

Start (20s)

Good afternoon everyone My name is Pham Thi Ngoc Mai I'm here to present my Bachelor thesis on Cluster Establishment in Vehicular Network - Connectivity Enhancement My presentation includes 5 parts: First, I will introduce about the technology and then the Methodologies, Tools and Implementation Next is Results and finally the Conclusion and Future work

Introduction (1m40)

I am going to start with VANETs, or Vehicular Ad-hoc Networks are the special type of Mobile Ad-hoc Network that aims at providing communication among vehicles on the roads. VANETs are introduced to help journey safer and the driving experience more comfortable and entertaining. There are two types of application in VANETs. Safety application and non-safety applications.

Focus on safety application, here, messages that contain critical events should be disseminated quickly and reliably to a target area so that proper actions can be taken to prevent users from accidents and hazardous situations. However communication high overload or failures come 2 nodes want to communicate with each other but they are too far and out of communication range.

To overcome this issue, one of the solutions is cluster establishment. The main ideas, we divide vehicles or nodes into groups called clusters. Each cluster has a management node which is called cluster head and others called cluster members.

My supervisor has an idea about a clustering protocol and i realizes that idea by constructing that protocol in each process, implement it on simulator ns3, and run simulation for the clustering protocol.

Method (3m20)

According to the idea of my supervisor, our system includes vehicles (nodes) and Road Side Unit (a device located road side to provide information to passing by vehicles) . We choose a nodes that has high number of neighboring nodes and closed distance to RSU to become Cluster Head. They will responsible for forwarding the packet within VANET.

To construct the protocol, I let nodes have different state and operate in many cycles (we call it Time Cycle). Each cycle has fixed pre-defined duration including some processes and I provide algorithm for the nodes in each process.

In more details, a Time Cycle has 3 process, in Beacon exchange, all nodes are STANDALONE which mean they are not belong to any cluster. next process is Cluster formation where some node become CH and the others become CM. In Data exchange node start exchanging message for safety and non safety applications.

Beacon exchange

Jump into beacon exchange, node broadcast messages periodically (we call beacon messages), it contains information about node's mobility and state. Nodes update the table of its stable neighbors (called neighbor list) and keep track with the closest RSU

Cluster formation

Nodes wait to become CH, the waiting time is calculated base on neighbor list size and the closest RSU. Node will joins other cluster if receives FormClusterMessage while waiting Otherwise, it declares CH itself and broadcast the FormClusterMessage By the end of the process, nodes are divided into one or more clusters

Data exchange

Communication in data exchange can be devided into 2 types Intra-cluster communication occurs when src and dest node are in the same cluster Node with directly send packet to dest or sent to CH and then CH forward it to dest Inter-cluster on the other hand, dest belongs to another cluster that CH dont know. Therefore CH sent packet to RSU. Here we assume RSU have access to the core network and the packet will be delivered to the closest RSU of the destination cluster.

Tools and Implementation (2p)

To implement the protocol, I use ns-3. a network simulator allows user simulate real world network on computer by writing C++ or Python script. I write a new application module and use the built-in functions from WAVE module of ns3. WAVE is Wireless Access in Vehicular Network - a system architecture for VANET introduced by IEEE standard.

We create 2 Applications classes to handle the behaviors of vehicles and RSUs We also create different Header classes for different type of packet exchanged in each process

Here is my design of 2 Applications. They extends the built-in application class, contain information about its mobility (position or velocity), VApplication for vehicles also have current process, and states

Next is the designs for headers. RsuBeaconHeader is for beacon message sent by Rsu VBeaconHeader is sent by vehicles DataHeader for data packet exchanged in Data exchange process FormClusterHeader is sent by CH

Results (5p)

We evaluate the protocol via two scenarios: stable scenario and non-stable scenario with using metric PDR: Packet Delivery Ratio which is the ratio of successfully received packets to the total sent.

In our scenarios, we construct experiments for nodes on a 3 lane road 100m long, move with constant velocity in same direction. We increase the number of nodes from 5 to 45 and we also have RSUs every 100m. In Stable scenario, nodes have same velocity or very close velocity so that the topology does not change overtime. Non-stable, nodes have different velocity and can be distributed into different clusters

Stable Scenario

The yellow line is the PDR for our clustering protocol. It outperforms with the case where no protocol is applied and nodes just blind-broadcast the packet - the blue line. The red line re-broadcast only shows a little improvement when the number of nodes are small, and gives no effects with higher number of nodes

Non-stable Scenario

For the non-stable scenario, the protocol shows a lower PDR compared to the first scenario, but still better than with broadcast and rebroadcast case. The packet lost in this scenario, caused by the lack of my implementation for inter-cluster communication in data exchange process

cycle time

We do another experiment for a network with wider velocity range and longer simulation time to see how the number of clusters evolves. If cycle time equals 33s, the number of clusters increases fast from 3 to 4 and to 6 in the 3rd cycle time. In 13s case, the No of clusters increases gradually and drops sometimes. In summary if we decrease the cycle time, the results of cluster establishment can up to date with the network topology and this may keep the comm within network more stable.

Conclusion (1p)

In conclusion, based on the idea of my supervisor, I have been constructed a clustering algorithm and implemented it by ns3 simulator. The implementation still lacks of the inter-communication in data exchange process. In the future, if this work can be done then our protocol can be evaluated comprehensively with more practical scenarios. And some specific parameters like cycle time, duration for each process or coefficients in waiting time formula can be analysed to improve the performance of data transmission in the future.

This is the end of my presentation. Thanks for your attentions.